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Introduction

The National Institute of Health Consensus Development Conference in 1985 recommended that Americans eat a diet with no more that 30% of the calories coming from fat, to reduce the risk factors associated with cardiovascular disease. Beef with a low-fat content could compose a greater portion of this recommended diet than beef with a high-fat content. There is a large base of experimental results on the effects of various factors such as genetics, feeding level, sex condition, exogenous biological growth stimulants, time on feed, and postweaning management on growth, composition and palatability of beef carcasses. Systems analysis through the use of computer models is an excellent means of integrating this existing knowledge. Computer models can be used to help identify feeding systems to produce leaner beef, provided these models are general enough to predict body composition with reasonable accuracy. Results from previous research have shown that some differences in body composition of cattle of the same breed and body weight may be predicted by rate of gain. Our objective was to develop and evaluate a dynamic computer simulation model that uses rate of gain to predict differences in body fat caused by plane of nutrition and to identify the model's range of applicability.

Procedures

Previous models that account for differences in body composition among cattle of similar genotype and weight caused by differences in energy intake require nutrient intakes as inputs. Nutrient intakes are difficult to predict and expensive to measure when animals are grazing. Our model is based on the premise that it is easier to predict or measure the growth patterns of cattle on a given nutritional regimen based on past experience or data than it is to predict or measure their nutrient intakes. The model assumes that protein is adequate for the amount of energy consumed. This restriction is based on the assumption that the costs relative to benefits of achieving protein adequacy are small compared to the costs relative to benefits of achieving energy adequacy.

Previous research has shown that daily gains for fat free matter and fat respond to increasing amounts of energy consumption as shown in Figure 1. Assuming the relationships in Figure 1, the percentage of fat free matter in gain decreases with increasing rate of empty body gain in a curvilinear fashion (Figure 2). The relationship shown in Figure 2 was used as a basis for developing a model that uses differences in rate of empty-body gain (caused by differences in energy consumption) to predict differences in body composition. The shape of the curve in Figure 2 depends on genotype, sex, stage of maturity (fraction of mature fat free matter in the body) and previous growth pattern. The model incorporates adjustments for these factors.

The model was evaluated with data from one unpublished and seven published experiments (Table 1). These experiments used several breeds of cattle, growing at rates that varied from small daily losses to high daily gains and various combinations of these growth rates. Ability of the model to simulate animal responses was first evaluated with respect to the accuracy with whichthe model simulated treatment means for fat percentage observed in the experiments. If the model simulated the observed animal responses closely, then paired values (experimental and simulated) should have a relationship which is close to one to one. Second, if there were important differences in body composition of animals at the same body weight, and these differences were associated with differences in nutrition, we wanted to evaluate the ability of the model to account for these nutritional effects.

Results

Observed and simulated treatment means for body fat percentage for the experiments listed in Table 1 are plotted in Figure 3. Data points lie close to the 45 degree line, which supports a one to one relationship between observed and simulated treatment means. However, the data plotted in Figure 3 do not distinguish between differences associated with weight and nutritional effects on body composition beyond those associated with body weight. To address this problem, observed and simulated nutritional effects on percentage body fat were obtained after adjusting for body weight differences. These nutritional effects are plotted in Figure 4. The results show that for experiments in which nutritional treatments had a significant effect on observed composition, the simulated data from the model also showed a similar significant effect. The results depicted in Figure 4 provide evidence that the model can predict differences in fatness of cattle caused by nutrition.

One of the outliers in Figure 4 represents a treatment in which a low protein diet was fed. In this case the model did not predict a significant nutritional effect on composition. One of the underlying assumptions of the model is that dietary protein is adequate, so inadequate protein may be responsible for the conflicting results obtained in simulating this experiment. Large effects of nutrition independent of changes in body weight are probably slightly underpredicted by the model, and the model will haveapproximately the same degree of accuracy in predicting composition as body weight alone in cases for which there are no nutritional effects on composition.

The following is a description of several areas where this model may be appropriate as a research/management tool.

1. Identification of postweaning systems of beef cattle production which would result in leaner carcasses at slaughter.
2. Characterizing the postweaning biological efficiency of different breed types when grown under different postweaning systems of production.
3. Identification of production systems to produce beef for different speciality markets.

In addition to these applications the model can be integrated into larger system models of the entire beef production system.

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[1]Williams and Keele are research animal scientists, and Bennett is the research leader, Production Systems Research Unit, MARC.

[2]The full report of this work was published in J. Anim. Sci. 70:841-866, 1992.

Table 1—Brief description of the experiments used to evaluate the model

Category	n	No. dietary treatments	No. slaughter groups per treatment	No. in initial slaughter group
Holstein steers	47	4	1	8
Angus steers	29	3	4	2
Hereford steers	37	4	2	0
Hereford females	35	4	2	0
Holstein steers-1	54	6	3	4
Holstein steers-2	48	4	3	4
Angus steers	71	2	5	0
Holstein steers	69	2	5	0
Angus steers	42	2	2	12
Charolais steers	41	2	2	12
Small frame	120	6	2,3	0
Large frame	120	6	2,3	0
Small frame	79	5	2,3	10
Large frame	82	5	2,3	10

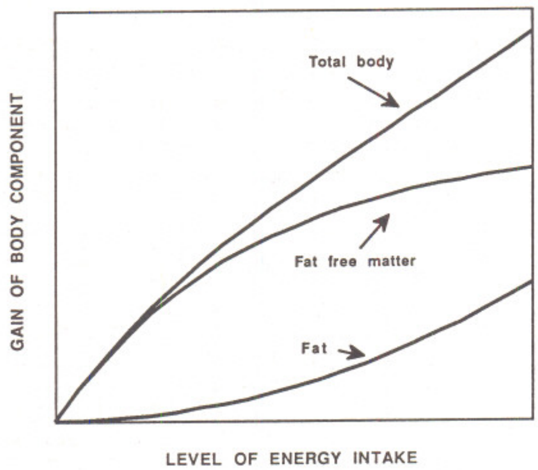

Figure 1 – Relationship between energy intake and daily gain of body chemical components when energy is the most limiting nutrient.

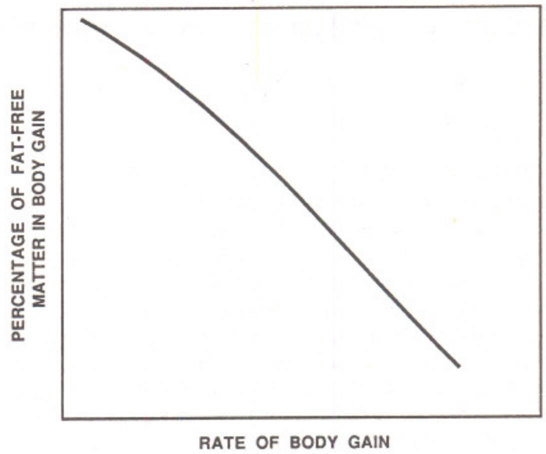

Figure 2 – Relationship between percentage fat free matter in gain and rate of body gain when differences in rate of body gain are caused by differences in energy consumption and energy is the most limiting nutrient.

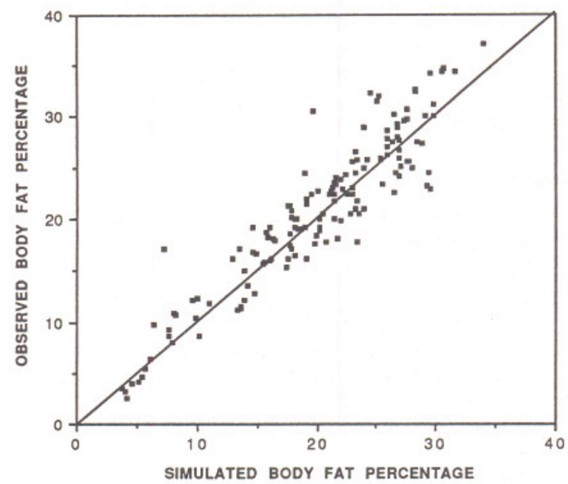

Figure 3 – Relationship between treatment means for observed body fat percentage and simulated body fat percentage.

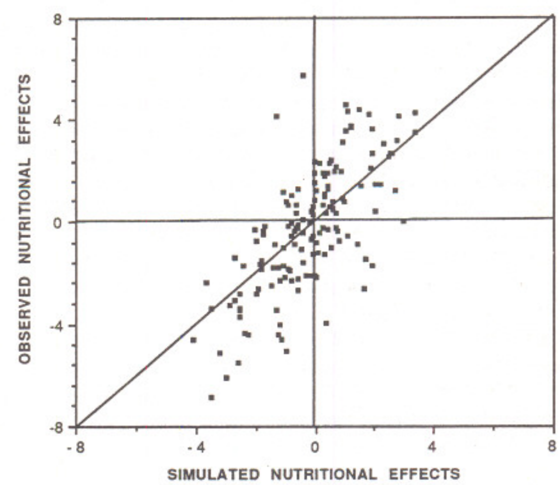

Figure 4 – Relationship between observed and simulated nutritional effects on body fat percentage.